FIG. 1

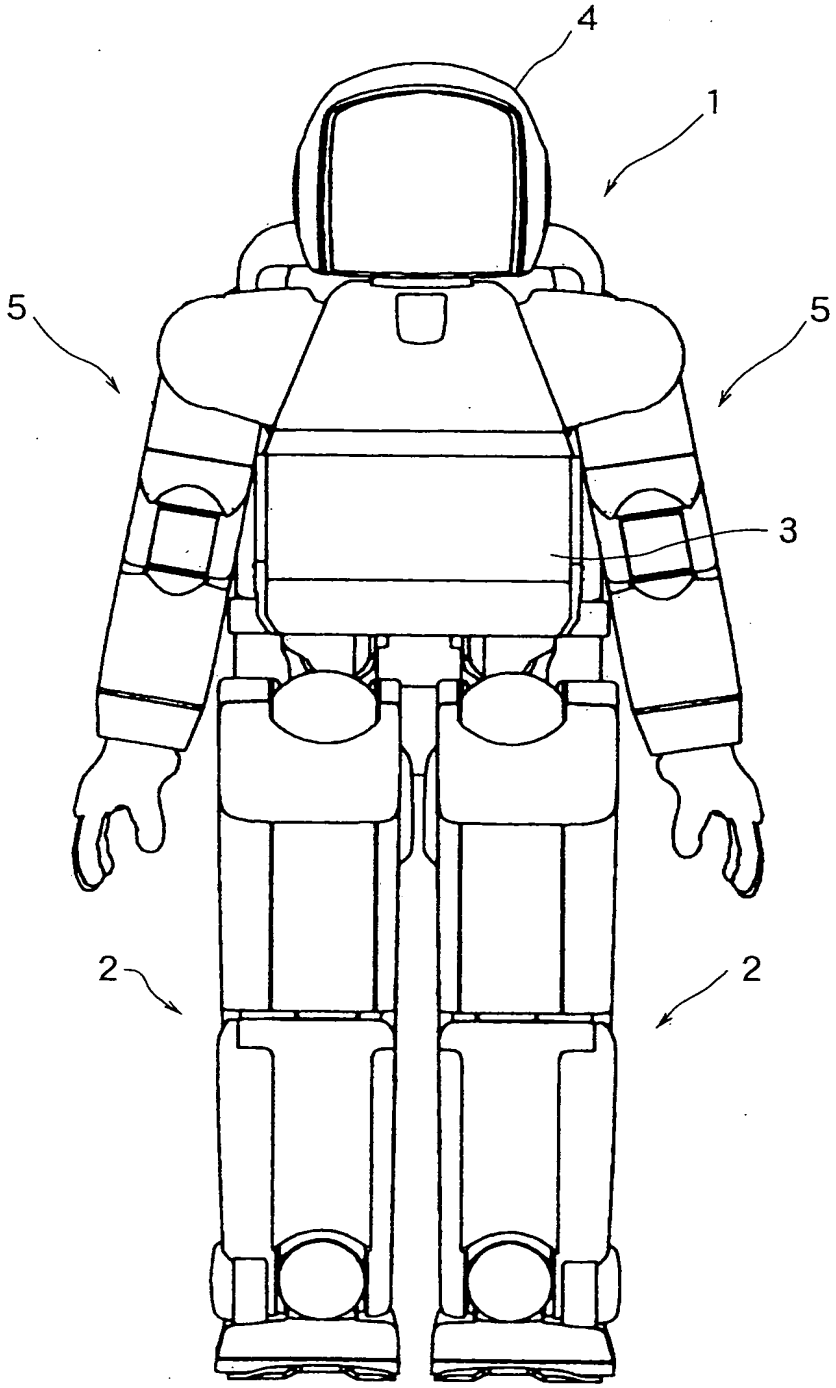


FIG. 2

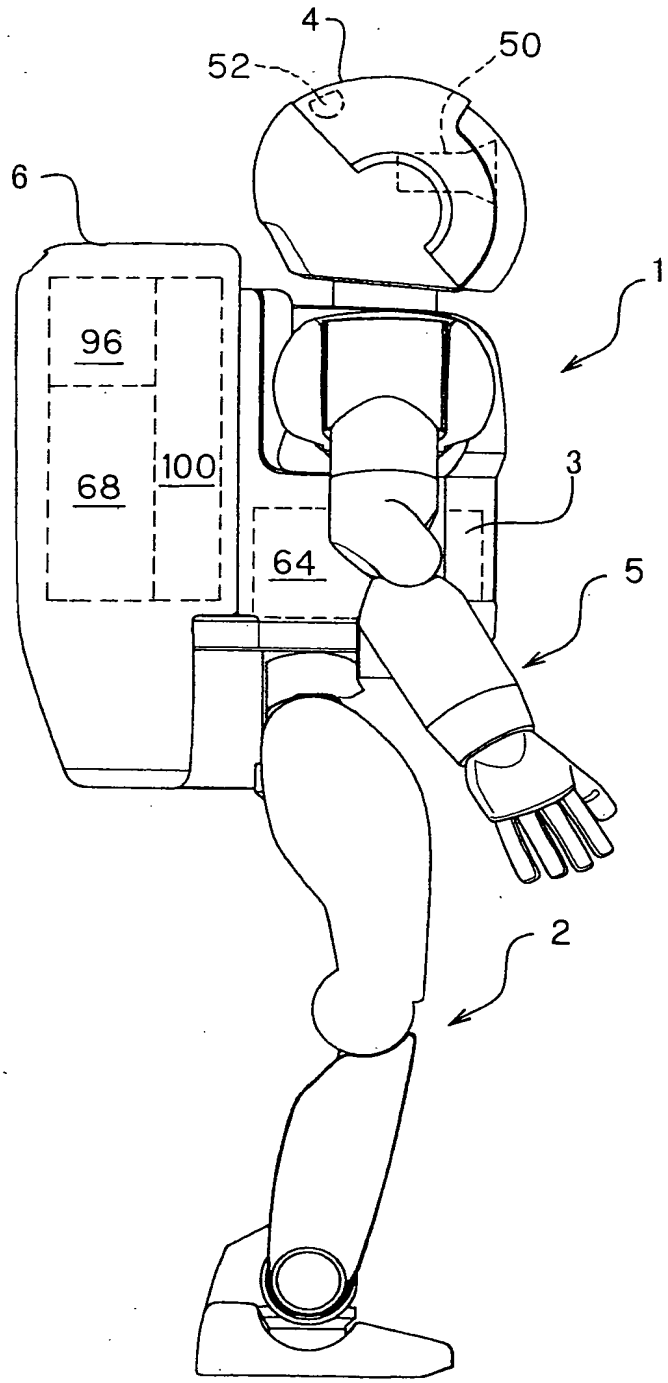


FIG. 3

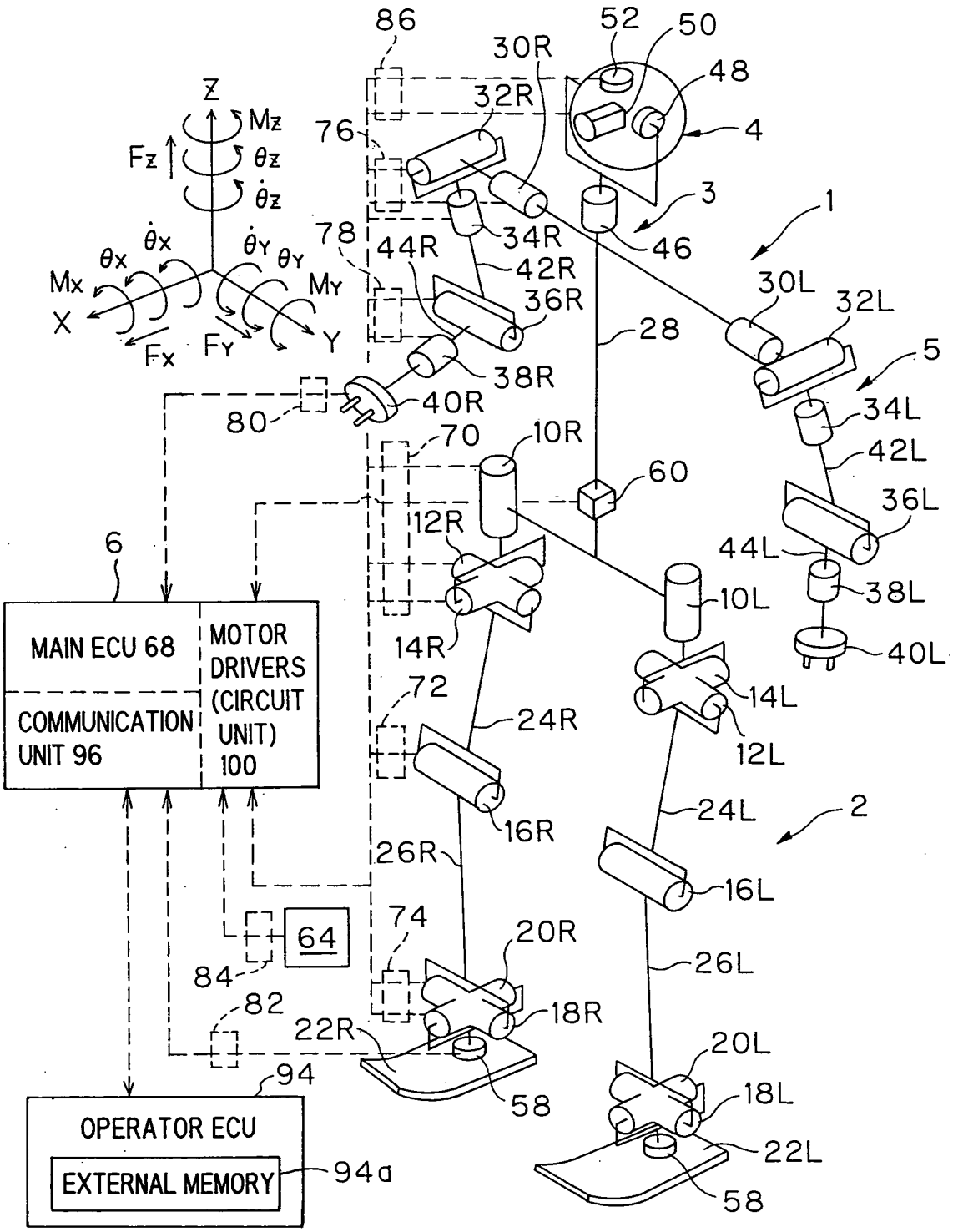

86
52
50
30R
48
32R
4
76
Z
Mz
Fz
θz
θz
3
1
78
θx
θx
θY
θY
44R
34R
46
Mx
MY
42R
30L
32L
X
36R
28
Y
Fx
FY
38R
5
40R
34L
80
70
10R
42L
60
36L
12R
6
44L
38L
10L
MAIN ECU 68
MOTOR DRIVERS (CIRCUIT UNIT) 100
14R
40L
72
14L
COMMUNICATION UNIT 96
24R
12L
16R
24L
2
26R
16L
64
74
20R
26L
84
82
18R
22R
20L
94
58
18L
OPERATOR ECU
22L
EXTERNAL MEMORY
94a
58

FIG.4

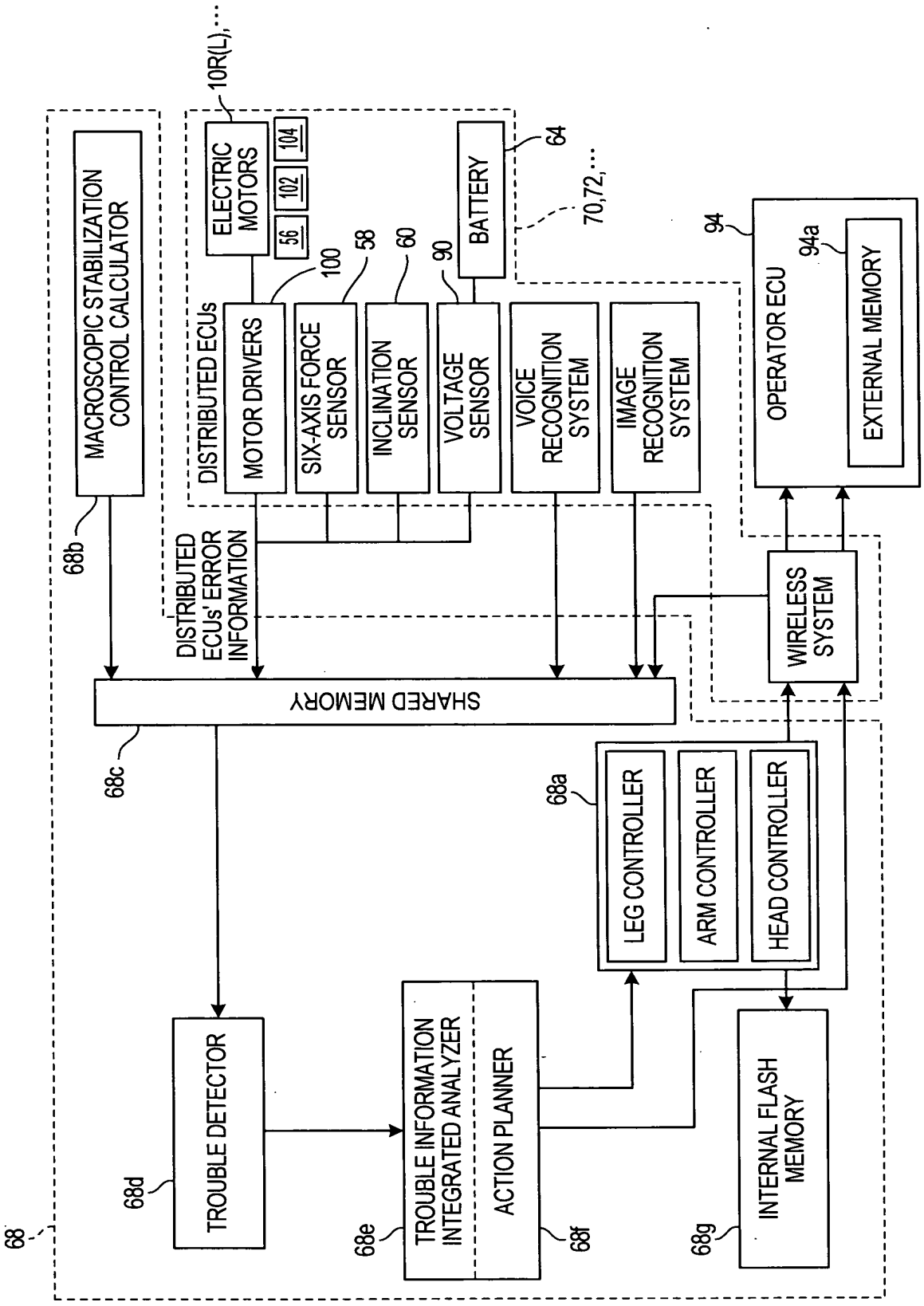

10R(L),...
ELECTRIC MOTORS
56
102
104
64
70,72,...
BATTERY
MACROSCOPIC STABILIZATION CONTROL CALCULATOR
DISTRIBUTED ECUs
MOTOR DRIVERS
100
SIX-AXIS FORCE SENSOR
58
INCLINATION SENSOR
60
VOLTAGE SENSOR
90
VOICE RECOGNITION SYSTEM
IMAGE RECOGNITION SYSTEM
94
OPERATOR ECU
94a
EXTERNAL MEMORY
68b
DISTRIBUTED ECUs' ERROR INFORMATION
WIRELESS SYSTEM
SHARED MEMORY
68c
68a
LEG CONTROLLER
ARM CONTROLLER
HEAD CONTROLLER
68d
TROUBLE DETECTOR
68e
TROUBLE INFORMATION INTEGRATED ANALYZER
ACTION PLANNER
68f
68g
INTERNAL FLASH MEMORY
68

FIG.5

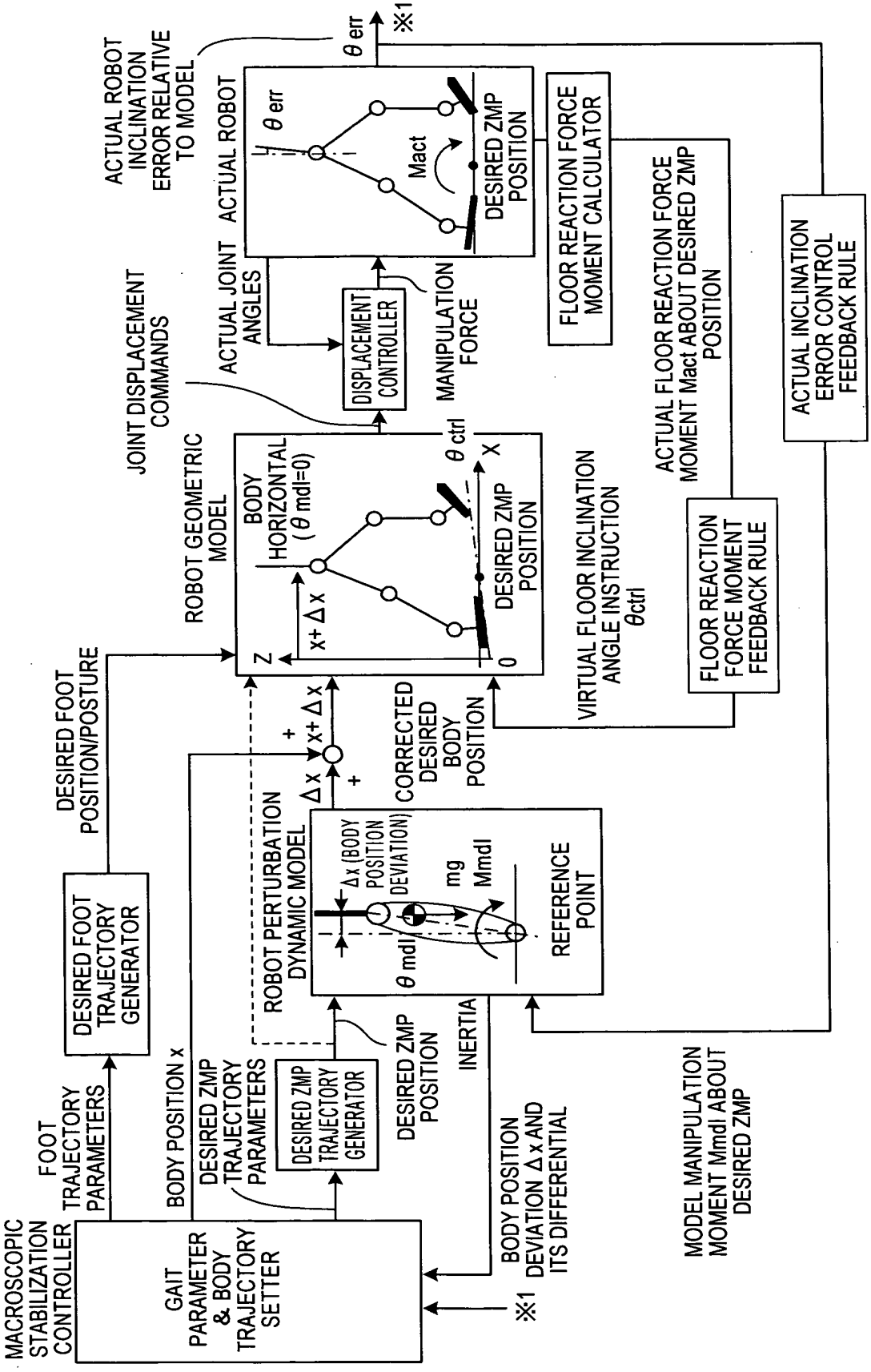

MACROSCOPIC STABILIZATION CONTROLLER
GAIT PARAMETER & BODY TRAJECTORY SETTER
FOOT TRAJECTORY PARAMETERS
BODY POSITION x
DESIRED ZMP TRAJECTORY PARAMETERS
DESIRED FOOT TRAJECTORY GENERATOR
DESIRED ZMP TRAJECTORY GENERATOR
DESIRED FOOT POSITION/POSTURE
DESIRED ZMP POSITION
INERTIA
BODY POSITION DEVIATION Δx AND ITS DIFFERENTIAL
※1
ROBOT PERTURBATION DYNAMIC MODEL
Δx (BODY POSITION DEVIATION)
θ mdl
mg
Mmdl
REFERENCE POINT
Δx
+
x+Δx
CORRECTED DESIRED BODY POSITION
ROBOT GEOMETRIC MODEL
BODY HORIZONTAL (θ mdl=0)
x+Δx
Z
θ ctrl
X
0
DESIRED ZMP POSITION
JOINT DISPLACEMENT COMMANDS
ACTUAL JOINT ANGLES
DISPLACEMENT CONTROLLER
MANIPULATION FORCE
ACTUAL ROBOT
θ err
Mact
DESIRED ZMP POSITION
ACTUAL ROBOT INCLINATION ERROR RELATIVE TO MODEL
θ err
※1
FLOOR REACTION FORCE MOMENT CALCULATOR
ACTUAL FLOOR REACTION FORCE MOMENT Mact ABOUT DESIRED ZMP POSITION
VIRTUAL FLOOR INCLINATION ANGLE INSTRUCTION θctrl
FLOOR REACTION FORCE MOMENT FEEDBACK RULE
ACTUAL INCLINATION ERROR CONTROL FEEDBACK RULE
MODEL MANIPULATION MOMENT Mmdl ABOUT DESIRED ZMP

FIG.6

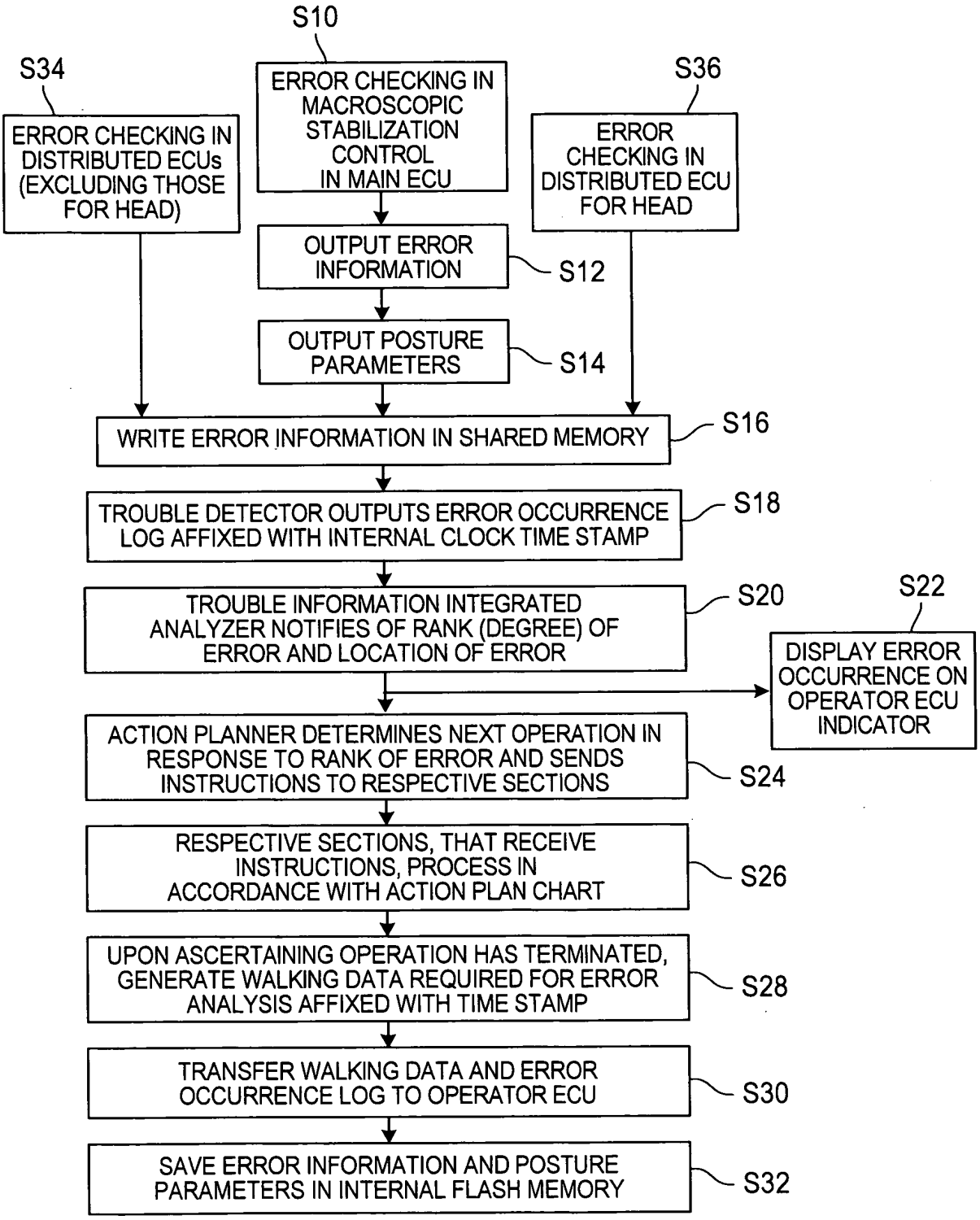

S10
ERROR CHECKING IN MACROSCOPIC STABILIZATION CONTROL IN MAIN ECU
S34
ERROR CHECKING IN DISTRIBUTED ECUs (EXCLUDING THOSE FOR HEAD)
S36
ERROR CHECKING IN DISTRIBUTED ECU FOR HEAD
OUTPUT ERROR INFORMATION
S12
OUTPUT POSTURE PARAMETERS
S14
WRITE ERROR INFORMATION IN SHARED MEMORY
S16
TROUBLE DETECTOR OUTPUTS ERROR OCCURRENCE LOG AFFIXED WITH INTERNAL CLOCK TIME STAMP
S18
TROUBLE INFORMATION INTEGRATED ANALYZER NOTIFIES OF RANK (DEGREE) OF ERROR AND LOCATION OF ERROR
S20
S22
DISPLAY ERROR OCCURRENCE ON OPERATOR ECU INDICATOR
ACTION PLANNER DETERMINES NEXT OPERATION IN RESPONSE TO RANK OF ERROR AND SENDS INSTRUCTIONS TO RESPECTIVE SECTIONS
S24
RESPECTIVE SECTIONS, THAT RECEIVE INSTRUCTIONS, PROCESS IN ACCORDANCE WITH ACTION PLAN CHART
S26
UPON ASCERTAINING OPERATION HAS TERMINATED, GENERATE WALKING DATA REQUIRED FOR ERROR ANALYSIS AFFIXED WITH TIME STAMP
S28
TRANSFER WALKING DATA AND ERROR OCCURRENCE LOG TO OPERATOR ECU
S30
SAVE ERROR INFORMATION AND POSTURE PARAMETERS IN INTERNAL FLASH MEMORY
S32

FIG.7

SUBJECT OF ERROR CHECKING	RANK (DEGREE) OF ERRORS	ACTION PLAN (STABLE STAGE TRANSITION CONTROL)
MACROSCOPIC STABILIZATION CONTROL	FATAL	CONTROL TO STOP ROBOT IMMEDIATELY
ELECTRIC MOTORS	SMALL	INFORM, BUT CONTINUE ROBOT CONTROL
	WARNING	CONTINUE CONTROL UNTIL COMPLETION OF WALKING STEP IN PROGRESS
	FATAL	CONTROL TO STOP ROBOT IMMEDIATELY
INCLINATION SENSOR	FATAL	SWITCH TO SUB-GYRO AND CONTROL TO STOP ROBOT IMMEDIATELY
SIX-AXIS FORCE SENSOR, ETC.	FATAL	USE SUBSTITUTE VALUE AND CONTROL TO STOP ROBOT IMMEDIATELY
BATTERY, WIRELESS SYSTEM, VOICE AND IMAGE RECOGNITION SYSTEMS	WARNING	CONTINUE CONTROL UNTIL COMPLETION OF WALKING STEP IN PROGRESS

10/540430

FIG.8

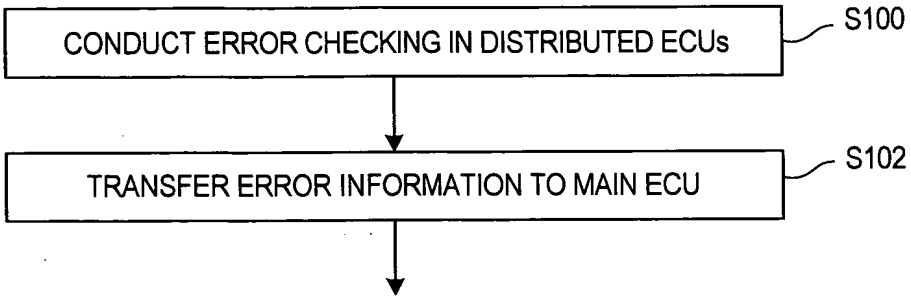

CONDUCT ERROR CHECKING IN DISTRIBUTED ECUs
S100
TRANSFER ERROR INFORMATION TO MAIN ECU
S102

FIG.9

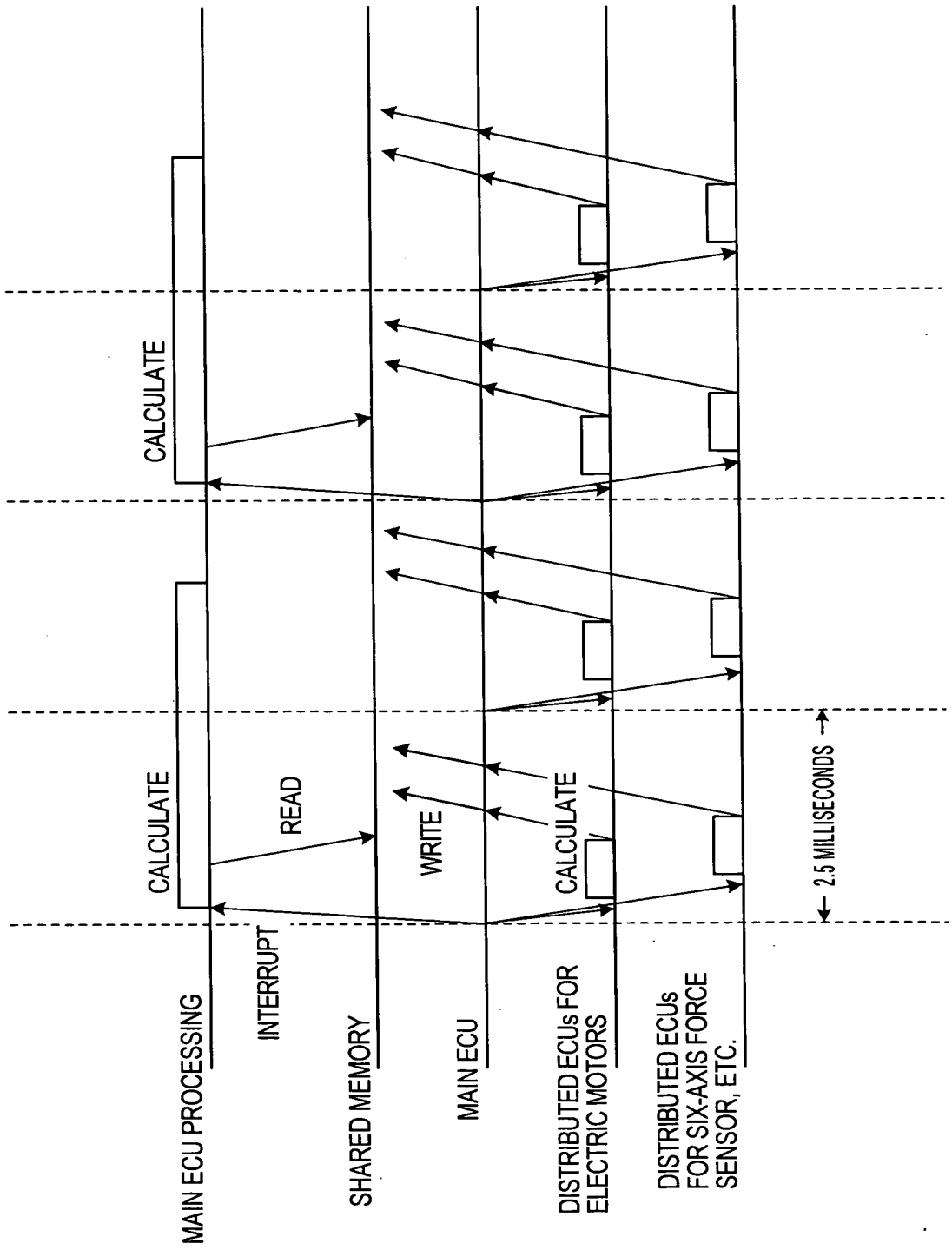

MAIN ECU PROCESSING
INTERRUPT
SHARED MEMORY
MAIN ECU
DISTRIBUTED ECUs FOR ELECTRIC MOTORS
DISTRIBUTED ECUs FOR SIX-AXIS FORCE SENSOR, ETC.
CALCULATE
READ
WRITE
CALCULATE
CALCULATE
2.5 MILLISECONDS

FIG.10

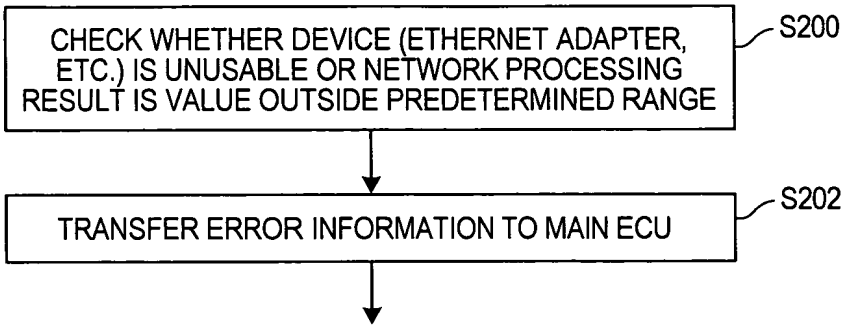

CHECK WHETHER DEVICE (ETHERNET ADAPTER, ETC.) IS UNUSABLE OR NETWORK PROCESSING RESULT IS VALUE OUTSIDE PREDETERMINED RANGE
S200
TRANSFER ERROR INFORMATION TO MAIN ECU
S202

FIG.11

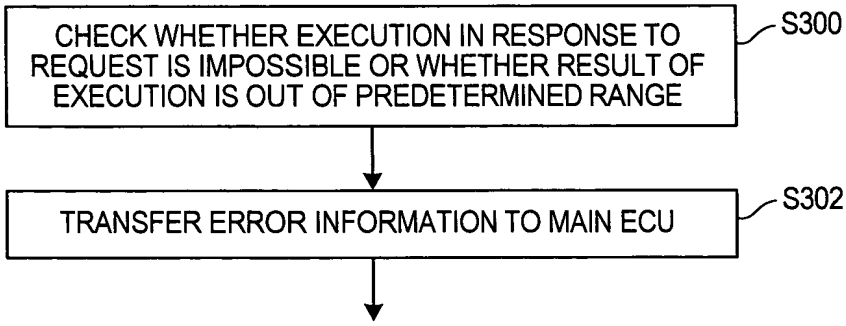
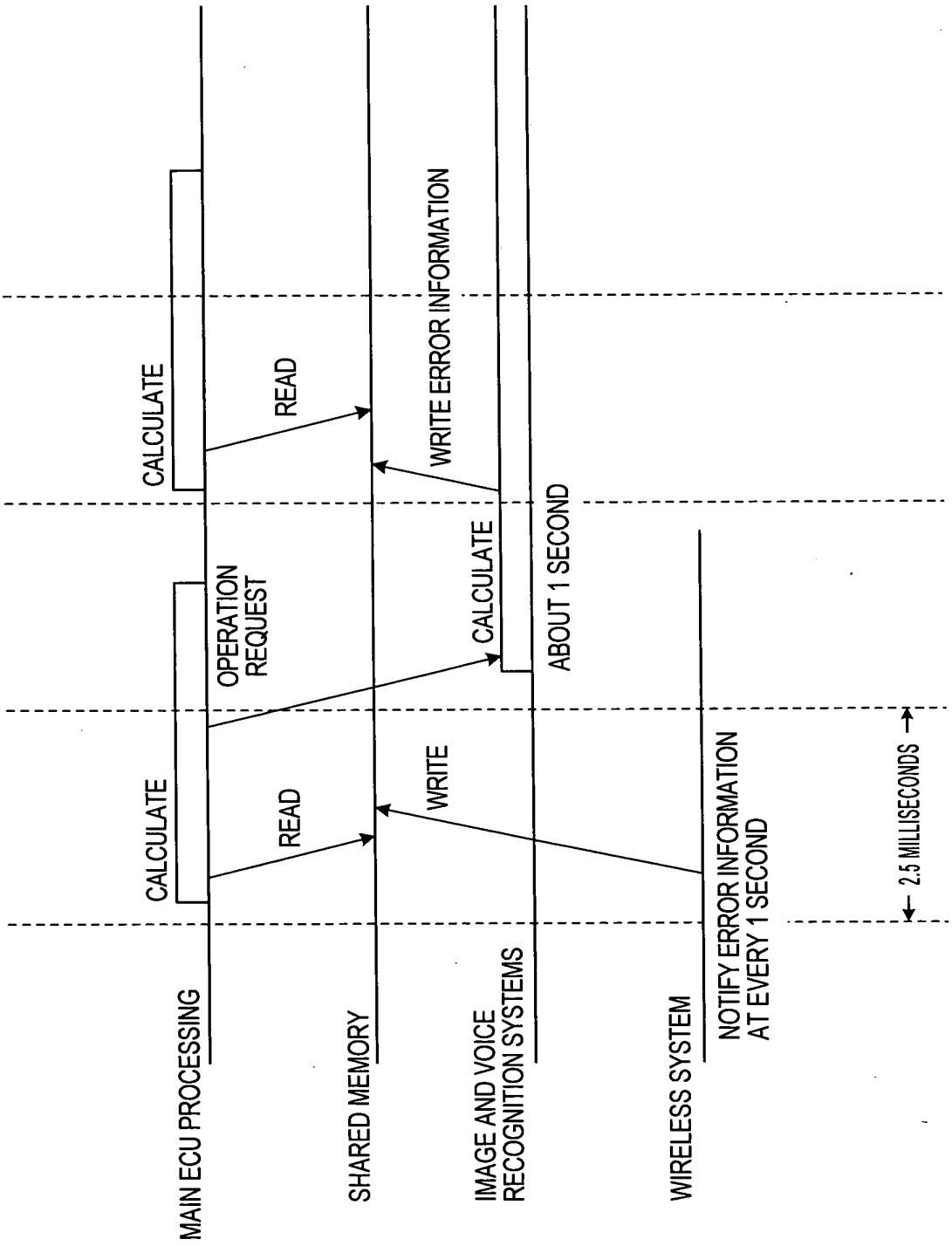

CHECK WHETHER EXECUTION IN RESPONSE TO REQUEST IS IMPOSSIBLE OR WHETHER RESULT OF EXECUTION IS OUT OF PREDETERMINED RANGE
S300
TRANSFER ERROR INFORMATION TO MAIN ECU
S302

FIG.12


MAIN ECU PROCESSING
SHARED MEMORY
IMAGE AND VOICE RECOGNITION SYSTEMS
WIRELESS SYSTEM
CALCULATE
READ
OPERATION REQUEST
CALCULATE
WRITE
CALCULATE
READ
WRITE ERROR INFORMATION
ABOUT 1 SECOND
NOTIFY ERROR INFORMATION AT EVERY 1 SECOND
2.5 MILLISECONDS